



CHAPTER 12: Program Design

PASTPAPERS

N.B. These pastpapers may rely on the knowledge gained from the previous chapters.

1 SEC'94-PAPER 2A-Q8

A computer is used to control the entrance and exit of a car park. The computer controls the automatic barriers at the entrance and exit, and monitors the number of cars in the car park. As a car approaches the entrance, the driver is issued with a ticket stamped with the time, and the entrance barrier is lifted. However, if the car park is full, the message FULL appears on a screen above the ticket machine.

When a car approaches the exit, the driver inserts the ticket into the exit machine and the computer calculates and displays the parking charge based on the elapsed time. When the driver inserts the correct amount of money into the exit machine, the exit barrier is lifted to let the car out.

- a. Briefly describe how the computer can tell when a car approaches the entrance or exit barriers. [2]

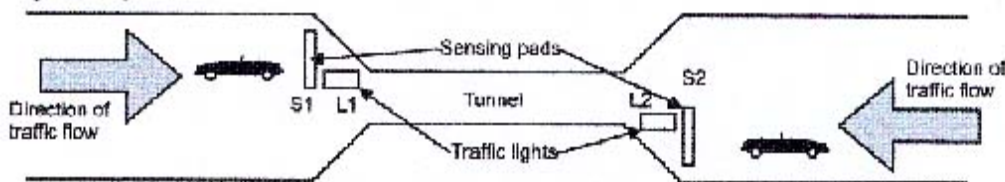
- b. Using a **flowchart** or **pseudocode**, describe the algorithm the computer uses to keep track of the number of cars currently in the car park. [4]

- c. Suppose a car enters the car park at time H1:M1:S1 and leaves at time H2:M2:S2 of the same day, and assume that the charge for using the car park is C cents per hour. Using pseudocode or high-level language of your choice, write an algorithm which calculates the parking charge given the values of H1, M1, S1, H2, M2, S2 and C. [3]

- d. What modifications will have to be made to this algorithm to allow for the possibility that a car stays in the car park overnight? [3]

2 SEC'95-PAPER 2A-Q1

A two-way road converges into a single-lane tunnel restricting traffic to one direction only at any given time (see diagram). Computer controlled traffic lights regulate the flow of traffic in the tunnel. The traffic lights can only show **RED** (an indication for traffic to stop) or **GREEN** (an indication that traffic may proceed).



- a. Assume that traffic is passing through the tunnel from left to right. What is the state of traffic lights L1 and L2. [1]
- b. The following is an algorithm to change the direction of flow of traffic through the tunnel when L1 is RED.

If L1 = red
Then L2 = red
Wait 5 seconds
L1 = green

Write a similar algorithm to change the direction of flow of traffic through the tunnel when L2 is RED. [2]

- c. Sensing pads S1 and S2 are activated whenever a car passes over them. [3]
Modify the algorithm given above to change the direction of flow of traffic for L1 = RED when a car is detected at the blocked end of the tunnel.
- d. Write the complete algorithm which controls the traffic lights. [5]
- e. What is the purpose of the 5-second delay in the algorithm given in question 1.b? [3]
- f. What practical problems with the flow of traffic may arise with this delay system? Suggest a suitable alternative solution. [6]

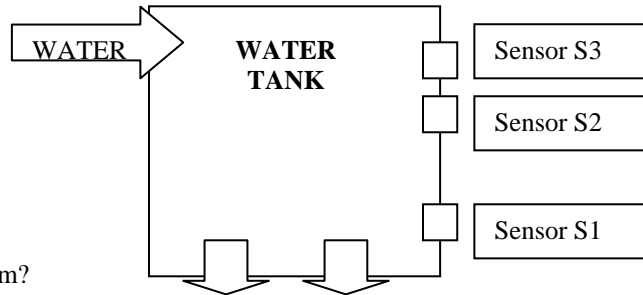
3 SEC'96-PAPER 2A-Q8

A computer monitors and controls the water level in a water tank. It uses sensors S1,S2 and S3 to monitor the water level, and pumps P1 and P2 to control the level of the water. The flow of water into the tank is **not** under control.

DUTY PUMP P1 starts when the water reaches high level S2 and continues working until the water level returns to low level S1

The algorithm for controlling this pump is:

1. If S2 then switch P1 on
2. Repeat until not (S1)
3. switch P1 off



a. What is the purpose of line 2 in the algorithm?

[3]

If the inflow of water is so great that the water level reaches the emergency level S3, then STAND BY PUMP P2 is switched on until the level of water returns to high level S2.

b. Write the algorithm that starts P2 and subsequently switches it off

[4]

c. Write the complete algorithm which controls the level of water in the tank.

[4]

To reduce wear-and-tear on the pumps, the DUTY PUMP is alternated on each operation of S2, i.e.

<i>1st operation</i>	<i>P1 is DUTY PUMP</i>	<i>P2 is STAND-BY-PUMP</i>
<i>2nd operation</i>	<i>P2 is DUTY PUMP</i>	<i>P1 is STAND-BY-PUMP</i>
<i>3rd operation</i>	<i>P1 is DUTY PUMP</i>	<i>P2 is STAND-BY-PUMP</i>

d. Briefly describe how the computer can keep track of which pump is the duty pump, and which is the stand-by pump.

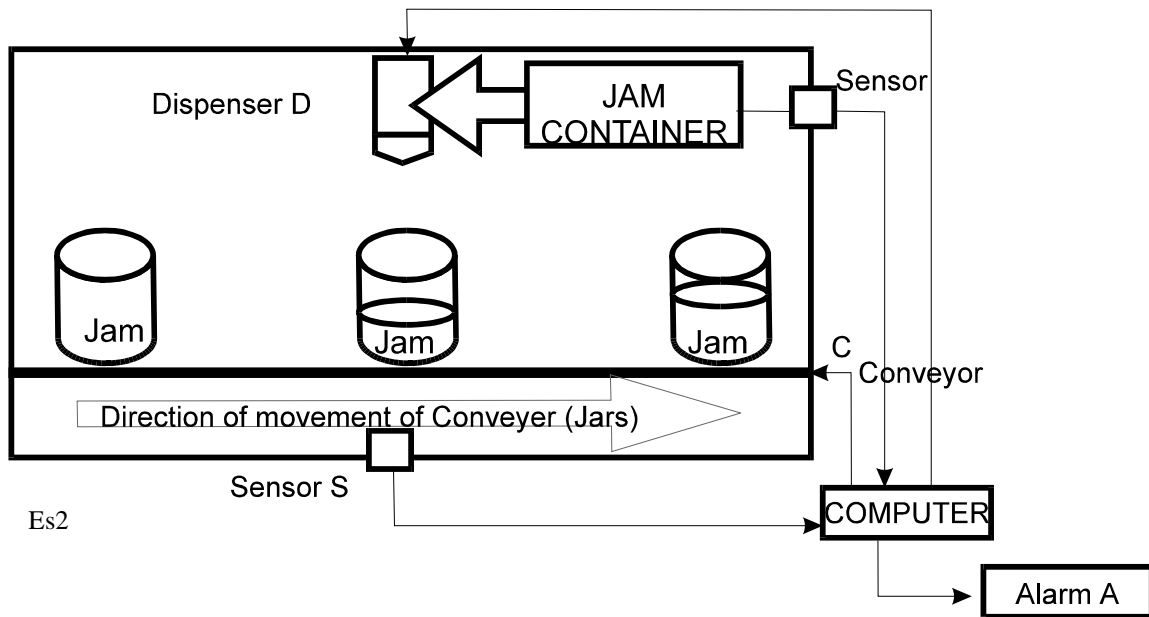
[3]

e. Modify the algorithm you developed in part to alternate the duty and stand-by pumps.

[3]

4 SEC '01-PAPER 2A-Q8

In a factory, jam jars are filled using an automated system.



Jars move down the production line on a conveyer belt C. A jam dispenser D lies above the conveyer belt. A sensor S is aligned with the dispenser. When a jar is directly below the dispenser, the conveyer belt C stops and the dispenser D empties its contents. The conveyer then starts again, while the dispenser is automatically refilled. The process repeats itself when another jam jar comes under the dispenser.

The algorithm for filling a jar with jam is

1. If S Then
2. Set C off
3. Set D on
4. Delay
5. Set D off
6. Set C on
7. Endif

- (a) Distinguish between a dedicated computer and a general-purpose computer [1]
- (b) What type of processing is required by this system? Give reasons for your answer. [3]
- (c) What is the purpose of the delay of line 4 in the above algorithm? [2]
- (d) If line 5 and line 6 were exchanged, in what circumstances would the process result in error. [3]

An operator in the factory uses a special purpose interfacing panel to operate this equipment. A start/stop switch is used to switch on the system.

- (e) Write the algorithm that continuously executes while the system is switched on. [4]

An alarm is activated if the jam container finishes while the system is working. This is detected by sensor SJ.

- (f) Modify the algorithm you wrote in part (e) to include this circumstance. [4]

